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WO 92/11727 A

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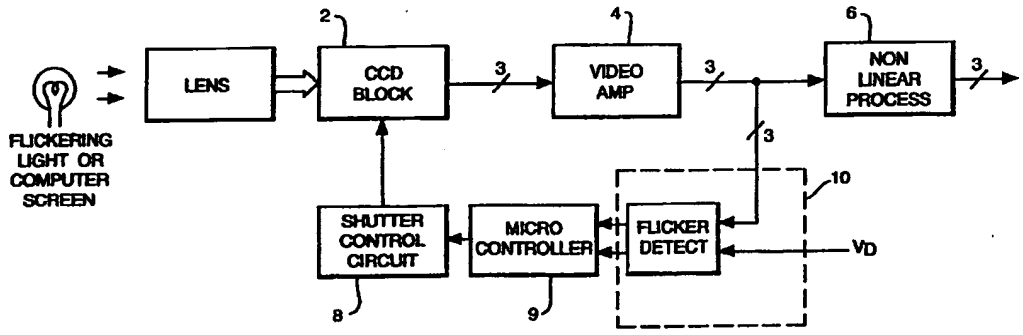
(54) Electronic shutter speed control

(57) A method and apparatus for electronic shutter speed control of a video camera operating by analysing for each field/frame the image signal produced by the photo detector 2 of the video camera so as to detect either (a) a band having a brightness level at a reduced level compared with the rest of the field/frame or (b) a band having a brightness level at an increased level compared with the rest of the field/frame; and increasing the shutter period upon detection of a band having a brightness of reduced level and decreasing the shutter period upon detection of a band having a brightness of increased level.

Fig.1.



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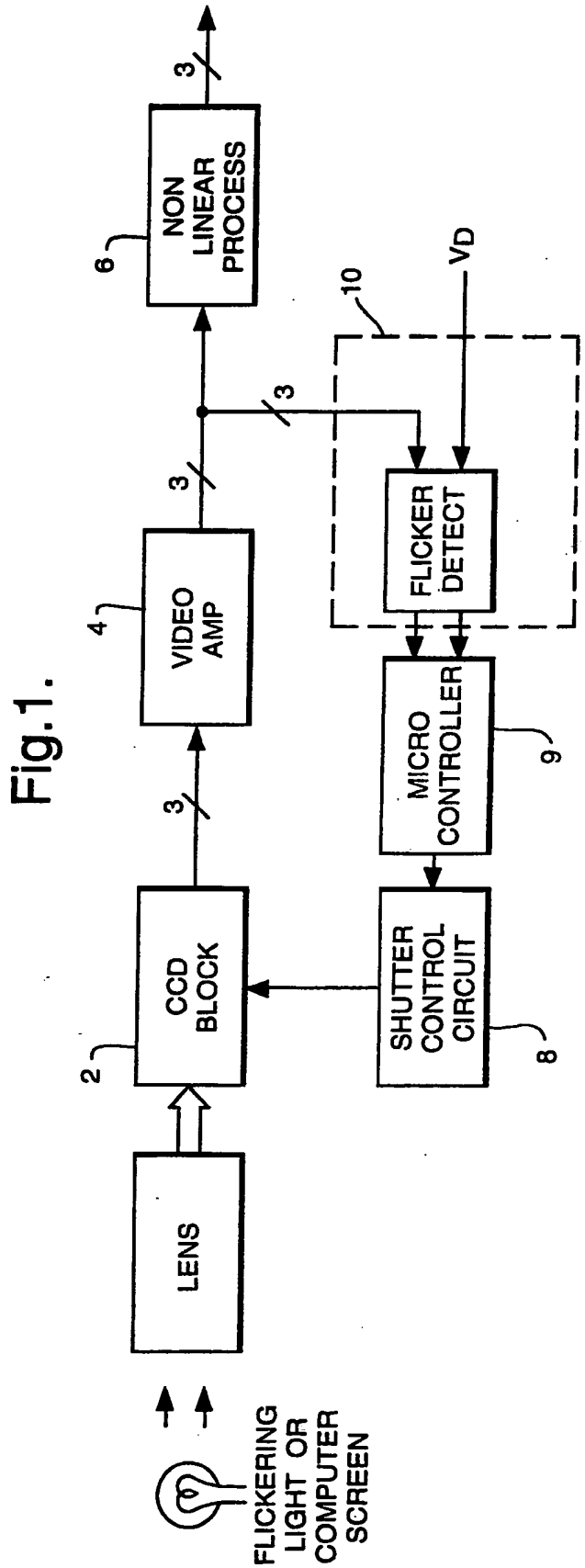

FLICKERING LIGHT OR COMPUTER SCREEN
LENS
CCD BLOCK
2
3
VIDEO AMP
4
3
NON LINEAR PROCESS
6
3
3
10
VD
FLICKER DETECT
MICRO CONTROLLER
9
SHUTTER CONTROL CIRCUIT
8

Fig.1.

Fig.2.

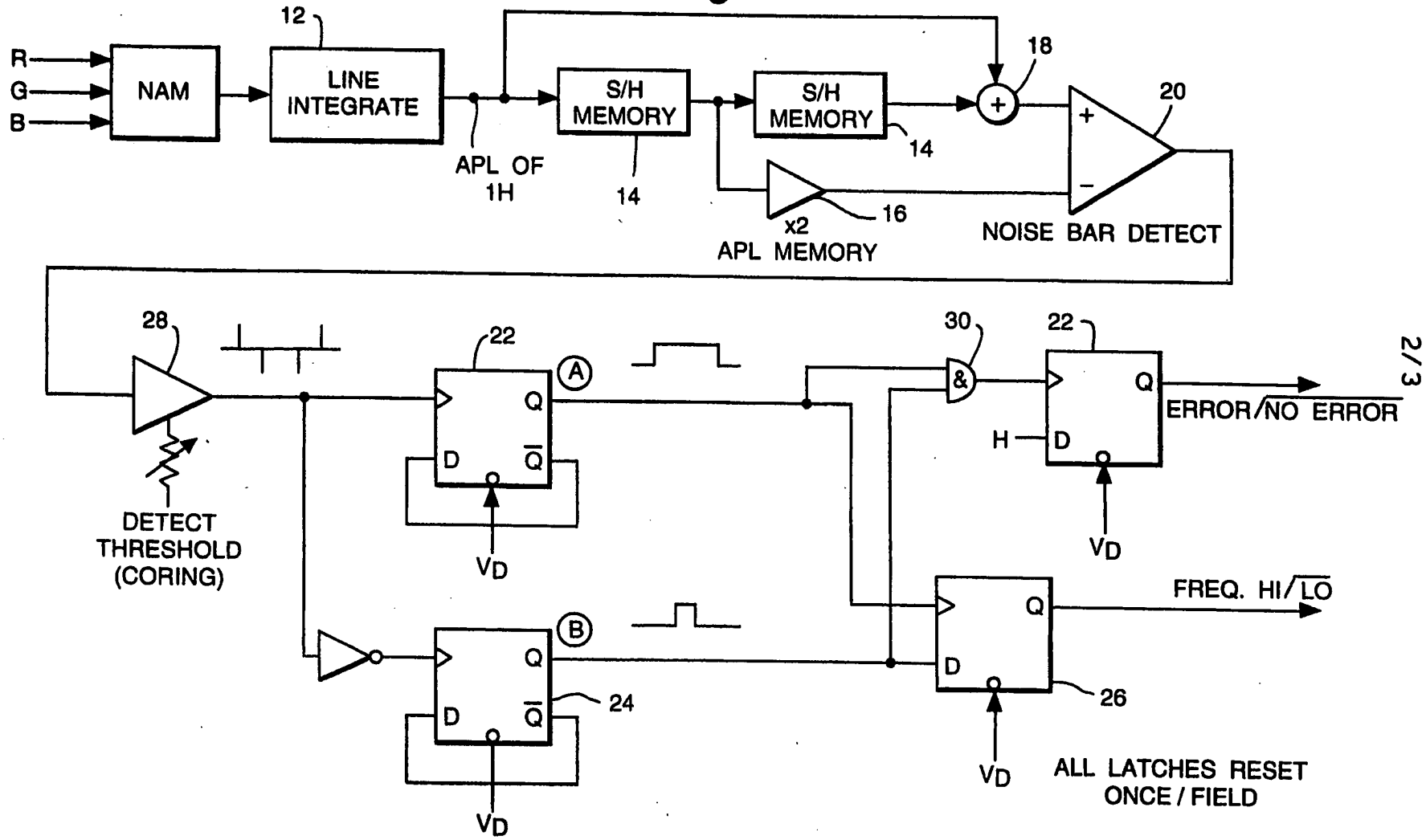

R
G
B
NAM
12
LINE INTEGRATE
APL OF 1H
S/H MEMORY
14
S/H MEMORY
14
18
20
+
−
x2
APL MEMORY
16
NOISE BAR DETECT
28
DETECT THRESHOLD (CORING)
22
A
Q
D
Q̄
VD
30
&
22
Q
H
D
ERROR/NO ERROR
VD
B
Q
D
Q̄
24
FREQ. HI/LO
Q
D
26
VD
ALL LATCHES RESET ONCE / FIELD

Fig.3A.

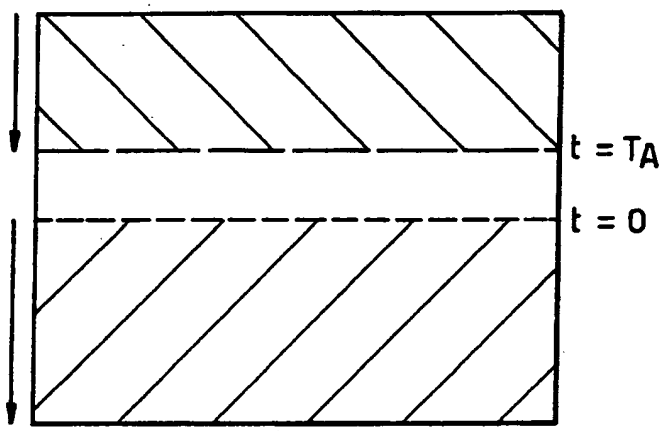
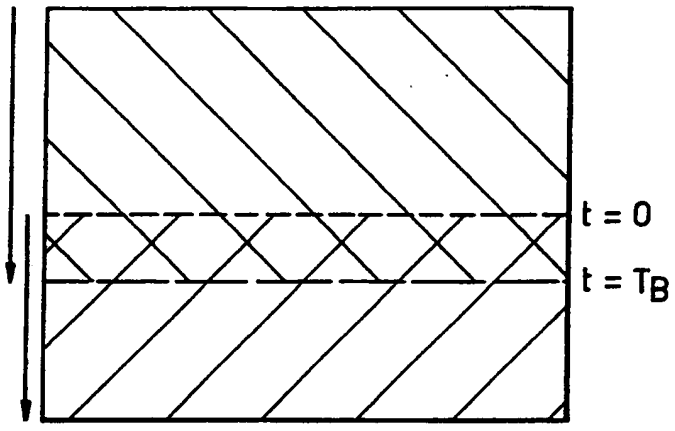


Fig.3B.



METHOD AND APPARATUS FOR ELECTRONIC SHUTTER SPEED CONTROL

The present invention relates to a method and apparatus for electronic shutter speed control and more particularly to a method and apparatus by which the electronic shutter speed of a video camera may be matched with the flicker rate of a light source, such as a computer monitor, to eliminate visible flicker on the camera output.

Since conventional video cameras operate at a fixed field/frame rate (50 hertz in the case of a PAL camera), when certain scanning light sources having a different flicker rate are filmed by the camera, the resulting output image may also include a disturbing visible flicker as a result of the frequency mis-match. In particular, a computer monitor or a television monitor operating to a different standard, may have a field/frame rate different to that of the video camera such that a visible flicker will occur on the camera's output at a frequency which is the difference between the light source (monitor/tv) flicker rate and the camera rate (50 hertz in the case of PAL).

Although cameras usually operate at a fixed field/frame rate, it is often possible to select various shutter speeds. In the case of CCD cameras this is achieved by selectively dumping signal charge during the early part of each field, thereby reducing the integration period of the image signal which is finally output at the field blanking and also reducing the shutter period. Thus, in a conventional circuit, the user may typically select six shutter speeds between 1/60 and 1/2000 of a second.

Using a similar method of shutter speed selection, it has been proposed to offer, for instance, 157 shutter period step settings between 1/50.4 and 1/125 second so that the shutter period may be adjusted to match almost any computer monitor vertical scanning rate with a high degree of accuracy.

Although this proposed system can avoid the disturbing effects of mis-matched light source and camera frequencies, it is inconvenient to use and requires either pre-selection of the correct shutter speed or trial and error on the part of the operator.

Thus, it is an object of the present invention to provide a method and apparatus by which the flicker resulting from mis-match of light source and camera frequencies may at least be reduced without the need of the complicated procedure outlined above.

According to the present invention there is provided a method of electronic shutter speed control of a video camera comprising the steps of:

analysing for each field/frame the image signal produced by the photo detector of the video camera so as to detect either (a) a band having a brightness level at a reduced level compared with the rest of the field/frame or (b) a band having a brightness level at an increased level compared with the rest of the field/frame; and

increasing the shutter period upon detection of a band having a brightness of reduced level and decreasing the shutter period upon detection of a band having a brightness of increased level.

According to the present invention there is also provided

an apparatus for electronic shutter speed control of a video camera comprising:

analysing means to be connected to the video camera for analysing each field/frame of the image signal produced by the photodetector of the video camera so as to detect either (a) a band having a brightness level at a reduced level compared with the rest of the field/frame or (b) a band having a brightness level at an increased level compared with the rest of the field/frame; and

means to be connected to the video camera for increasing the shutter period upon detection of a band having a brightness of reduced level and decreasing the shutter period upon detection of a band having a brightness of increased level.

Thus, when the shutter period of a video camera is too slow in comparison to, for instance, a computer monitor, during one field/frame of the camera, the monitor will scan a part of the screen twice, resulting in a horizontal bar of twice the correct amplitude (i.e. a brighter bar). Conversely, when the camera shutter period is too short, a part of the computer screen will not be scanned during that period and so a dark horizontal bar will appear on the screen.

Thus, by detecting a bright or dark bar and adjusting the shutter speed of the camera accordingly (whether or not this is of the CCD type shutter described above), the mis-match flicker may be eliminated.

Not only will the electronic shutter speed control of the present invention find the correct shutter period from above or below, but it will also automatically track any variations in the light source/monitor scanning frequency. This is

particularly important, since the monitor and camera are not frequency locked and will therefore drift apart sooner or later even if the correct shutter period is initially established. Furthermore, it may automatically track the effective differences in camera and monitor scanning frequencies caused by tilting the camera up and down ready to the position of the monitor. Although the time constant/speed of operation of the circuit needs careful consideration to avoid excessive lag between the error appearing and being corrected (and the appearance on the screen of the error is necessary to trigger the correction process), if the circuit operates fast enough, the artefacts of correction may be less noticeable than an uncorrected error.

The invention will be more clearly understood from the following description, given by way of example only, with reference to the accompanying drawings in which:

Figure 1 shows an overall block diagram for a video camera incorporating the electronic shutter speed control of the present invention;

Figure 2 shows a block diagram of an embodiment of the present invention; and

Figures 3a and 3b illustrate schematically the effect of camera shutter periods which are too small and too large respectively.

Referring to Figures 3a and 3b, it may be seen that when the shutter period of a video camera is not adjusted to the same frequency as the computer monitor which it is filming, either a bright or a dark horizontal bar will be seen on the cameras output. For example, as seen in Figure 3b, if the

camera scans too slowly compared with the computer monitor, the monitor will scan a part of the screen twice during one scan of the camera. The double scan area, indicated by the double cross hatching, will therefore be twice the correct amplitude.

In more detail, if the period of the shutter is T_B and the monitor scan is half way down the screen at $t = 0$, if T_B is too great, then by $t = T_B$ the monitor will have scanned beyond the original half way position.

Conversely, if the camera scans too quickly, the monitor will not scan part of the computer screen (at $t = T_A$, it will not have reached the half way position) and so a dark bar will occur on the camera's output. It may be noted that the output will not be completely black because the monitor will maintain some light output from the previous scan, but it will be at a reduced level compared with the rest of the screen.

Thus, the presence of a light or dark horizontal bar can therefore be used to decide if the shutter period is too small or too large and the ideal shutter period may be detected by the absence of both.

With reference to Figures 1 and 2, a particular embodiment of the present invention using a CCD camera with a scan type output will be described below.

The input to the shutter speed control circuit 10 is taken from a suitable point in the camera video circuit, before any non linear processing functions, so as to allow accurate detection of the higher or lower signal levels of the noise bars and avoid compression of the measured signals resulting from gamma and knee correction.

Thus, as illustrated in Figure 1, three colour signals

are passed from the CCD block 2 to the video amplifier 4 and on to both the speed control circuit 10 and the non-linear processing 6. The shutter speed control circuit 10 then determines whether the shutter speed should be higher or lower and controls the shutter control circuit 8 by means of the micro computer 9.

It may be noted that by combining in the frame integration mode, it is also possible to produce shutter speeds below the standard rates of 50 herts in PAL and 60 herts in NTSC.

Referring to Figure 2, a variable mix (NAM) of the three primary colours supplied from the video amplifier 4 is used to feed an integrating circuit 12 which produces a signal whose level is proportional to the average picture level (APL) of one tv line and is independent of the colour of the scene. The integration of a whole line should average out the many level variations during that one line period resulting from the scene detail.

The APL of three consecutive lines are processed by a noise bar detection circuit comprising sample and hold memories 14, multiplier 16, adder 18 and subtractor 20. The consecutive lines comprise the current line (n) and the output of the two sample and hold circuits 14 used to memorise the APL of the two previous lines (n-1) and (n-2).

This detection circuit is similar to a vertical detail circuit which correlates the signal of consecutive lines so as to output pulse signals only where differences in signal level between consecutive lines exist.

A dark to light transition will cause the detector to

output first a positive pulse, followed by a negative pulse, whereas a light to dark transition will cause the negative pulse to be output first followed by the positive pulse. The order in which these pulses are output with respect to the beginning of the vertical period is the criterion used to determine if the horizontal bar is light or dark and hence whether to increase or decrease the shutter speed. When no frequency error exists, neither light nor dark bars are seen on the picture and so no level change exists and no pulses are output by the detector. This is the criterion used to decide if an error exists.

The edge triggered latch circuits 22, 24 and 26 interpret these conditions and indicate to the control micro computer 9 whether to increase or decrease the shutter speed. They function to compare the time periods between consecutive high pulses (latch 22) and consecutive low pulses (latch 24) as indicated by (A) and (B) in Figure 2. If the shutter period is too long (giving a light bar), the pulse width (A) is longer than the pulse width (B), whereas in the case of a shutter period which is too short (dark bar) the pulse width from latch 22 would be shorter than that from latch 24.

Thus, this electronic shutter speed control circuit will automatically adjust the shutter speed without the need of any manual intervention on the part of the operator.

The circuit of Figure 2 also incorporates two additional measures to avoid incorrect detection.

Firstly, the output of the detection circuit (subtractor 20) is passed through a dual edged threshold (coring) circuit 28. By virtue of this circuit, small differences in APL

between consecutive tv lines due to particular picture content are ignored and only the large amplitude changes caused by the light or dark horizontal bars will result in pulses being passed on to the latches 22, 24.

Secondly, an AND circuit 30 is provided to AND together the outputs of latches 22 and 24 i.e. wave forms A and B. If only one of the latches 22 and 24 has a pulse wave form A or B, this wave form is considered as a spurious signal. Thus, unless the AND validates the frequency high/low output of latch 26, it will be ignored by the micro computer 9. In addition this serves to indicate when the shutter speed error has been corrected, as neither A nor B pulses will exist.

Finally, with reference to Figure 2, since the position of the light or dark bar is random with respect to the top of the cameras picture, the detection of error/no error and frequency high/low is made only once per field by micro computer 9 and the latches of the circuit are re-set by the vertical drive. Thus, by this method, the position of the light or dark bar with respect to the camera vertical phase will have no effect. Furthermore, in order to reduce the risk of false operation of the circuit, the initial adjustment can be performed as a "set-up" on a plain field on the computer screen.

Although the described embodiment uses analog integrators and sample/hold gates in the detector (so that this could be applied retrospectively to current camera types), and implementation is also possible using equivalent digital components (accumulators, memories, adders etc) ideal for DSP camera products.

While the present invention has been described with reference to a standard CCD video camera of the type producing a scan output, it is equally applicable, by use of different detection and control means, with any other form of video camera.

CLAIMS

1. A method of electronic shutter speed control of a video camera comprising the steps of:

analysing for each field/frame the image signal produced by the photo detector of the video camera so as to detect either (a) a band having a brightness level at a reduced level compared with the rest of the field/frame or (b) a band having a brightness level at an increased level compared with the rest of the field/frame; and

increasing the shutter period upon detection of a band having a brightness of reduced level and decreasing the shutter period upon detection of a band having a brightness of increased level.

2. A method of electronic shutter speed control according to claim 1 wherein said step of analysing includes:

detecting transitions of relative brightness levels from high to low and from low to high.

3. A method of electronic shutter speed control according to claim 1 or 2 and for use with a camera producing a scan type image signal wherein said step of analysing includes:

calculating the average brightness level of each line of a field/frame and comparing the average brightness levels of consecutive lines.

4. A method of electronic shutter speed control according to claim 3 wherein said step of comparing comprises comparing twice the average brightness level of one line with the sum of the average brightness level of the next line and the average brightness level of the previous line.

5. A method of electronic shutter speed control

according to any preceding claim wherein detected bands of increased or reduced brightness level below a predetermined threshold are ignored.

6. An apparatus for electronic shutter speed control of a video camera comprising:

analysing means to be connected to the video camera for analysing each field/frame of the image signal produced by the photodetector of the video camera so as to detect either (a) a band having a brightness level at a reduced level compared with the rest of the field/frame or (b) a band having a brightness level at an increased level compared with the rest of the field/frame; and

means to be connected to the video camera for increasing the shutter period upon detection of a band having a brightness of reduced level and decreasing the shutter period upon detection of a band having a brightness of increased level.

7. An apparatus for electronic shutter speed control according to claim 6 and for use with a camera producing scan type image signals wherein said analysing means includes:

means for calculating the average brightness level of each line of a field/frame and means for comparing the average brightness levels of consecutive lines.

8. An apparatus for electronic shutter speed control according to claim 7 wherein said means for comparing in use compares twice the average brightness level of one line with the sum of the average brightness level of the next line and the average brightness level of the previous line.

9. An apparatus for electronic shutter speed control according to claim 6, 7 or 8 wherein said analysing means

comprises detecting means for detecting transitions from high to low and from low to high of relative brightness levels.

10. An apparatus for electronic shutter speed control according to claim 9 wherein said analysing means in use outputs selectively a positive pulse followed by a negative pulse or a negative pulse followed by a positive pulse according to what transition is detected.

11. An apparatus for electronic shutter speed control according to claim 10 wherein the negative and positive pulses are of an amplitude relating to the amplitude of the detected transition.

12. An apparatus for electronic shutter speed control according to claim 11 wherein said analysing means includes means for filtering out negative and positive pulses having an amplitude below a predetermined threshold.

13. A video camera including a connected apparatus for electronic shutter speed control according to any one of claims 6 to 12.

14. A video camera according to claim 13 wherein said analysing means is connected to the video camera at a point at which the image signal has not yet been subjected to any non-linear processing.

15. A method of electronic shutter speed control substantially as hereinbefore described with reference to and as illustrated by the accompanying drawings.

16. An apparatus for electronic shutter speed control of a video camera constructed and arranged substantially as hereinbefore described with reference to and as illustrated by the accompanying drawings.

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Patents Act 1977
E niner's report to the Comptroller under Section 17
(The Search report)

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Relevant Technical Fields

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(ii) Int Cl (Ed.5) H04N (1/36, 5/225, 5/235, 5/238)

Search Examiner
J M McCann

Date of completion of Search
14 January 1994

Databases (see below)
(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii)

Documents considered relevant following a search in respect of Claims :-
1,6

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages	Relevant to claim(s)
A	WO 92/11727	1,6

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).